Patent Claims:

1. A method for manufacturing paper, in which method a filler-containing paper pulp is fed at a predetermined consistency into the forming section of a paper machine, water is removed from the paper pulp by allowing the pulp to drain through a water permeable forming base, such as a wire, and the paper web thus produced is dried and finished in order to produce a finished paper product, **characterised in that** the paper pulp is produced as follows:

(a) the fibre material containing fibres used as raw material for paper pulp is fed into a precipitation reactor;

(b) a reactive mineral material, such as calcium hydroxide ($Ca(OH)_2$), is fed into the precipitation reactor;

(c) the reactive mineral material and the fibre material are combined to form a fibre suspension in the precipitation reactor and/or before feeding these materials into the precipitation reactor;

(d) the fibre suspension is brought into contact with the precipitant of said reactive mineral material in the precipitation reactor, in order to at least partly precipitate the reactive mineral material in the suspension, thus precipitating at least a part of the thus formed precipitated mineral material onto the fibres in the fibre suspension, in such a manner that

(d1) a gas is fed into the precipitation reactor, which gas contains a precipitant precipitating said mineral material, such as carbon dioxide, in order to form a gas space containing said precipitant inside the precipitation reactor, and (d2) the fibre suspension fed into the precipitation reactor and/or formed therein is dispersed, or scattered, in small parts, such as drops and/or particles containing solid matter and/or liquid, into said gas space;

(e) the treated fibre suspension is discharged from the precipitation reactor;

whereafter the paper pulp formed by the fibre suspension is fed into the forming section of the paper machine and paper is formed by allowing the pulp to drain through a water permeable forming base.

2. A method as claimed in claim 1, **characterised in that** in phase (d2) the liquid phase of the fibre suspension is dispersed in mainly <10 mm, typically <1 mm liquid drops into the gas space.

3. A method as claimed in claim 1, **characterised in that** forces are exerted on the fibre suspension in an activation zone located in front of the precipitation reactor or at the starting point of the precipitation reactor in relation to the flow direction of the fibres, which forces activate the fibres in a manner that enhances the capacity of the fibres to bond together and to bind the precipitating and/or precipitated mineral material.

4. A method as claimed in claim 3, **characterised in that,** in order to activate the fibre suspension, forces such as repeated impacts, counter impacts shearing forces, turbulence, over- and under-pressure pulses or other similar forces are exerted on it, which forces

- mechanically activate the fibres, particularly the surfaces of the fibres, for example by fibrillating or grinding the fibres or by opening the inner parts (lumen) of the fibres to the mineral material, and/or
- chemically activate the surfaces of the fibres, for example, by forming active OH-groups on the surfaces of the fibres.

5. A method as claimed in claim 3, **characterised in that** the fibre suspension flow flowing through the activation zone is subjected to repeated powerful impacts and counter impacts created in the fibre suspension flow by blades or the like moving at 5–250 m/s.

6. A method as claimed in claim 3, **characterised in that** in the activation zone of the precipitation reactor, there is an impact mill-type flow-through mixer, which has several, typically 3–8, most typically 4–6, concentric cages provided with blades, of which cages at least every other cage functions as a rotor, and the cages adjacent to said cages function as stators or rotors, the speed difference of the adjacent cages being 10–500 m/s, typically 50–200 m/s,

- the fibre suspension is fed through the flow-through mixer and radially outwards from cage centres, as the blades on the cages bring repeated impacts, counter impacts, shearing forces and turbulence and/or over- and under-pressure pulses, which together activate the fibres, to bear on the outward flowing fibre suspension.

7. A method as claimed in claim 6, **characterised in that** at least part of the gas to be fed into the precipitation reactor, containing the precipitant for precipitating the mineral material, is fed into the reactor through the activation zone, enabling the fibres activated in this activation zone to come into contact with said precipitant immediately during the activation or directly after it.

8. A method as claimed in claim 3–7, **characterised in that** the residence time of the suspension containing the fibre material and the reactive mineral material in the activation zone is short, <10 seconds, typically <2 seconds, most typically <1 second.

9. A method as claimed in claim 1, **characterised in that** a gas containing >5%, typically >10% of the precipitant, such as carbon dioxide, is fed into the precipitation reactor.

10. A method as claimed in claim 1, **characterised in that**

- the gas containing the precipitant is pure or nearly pure carbon dioxide, flue gas or another carbon dioxide-containing gas, or contains other gas suitable

for precipitating the mineral material used, or is a mixture of these gases, and that

- the gas containing the precipitant is fed into the precipitation reactor in such a manner that it will create an over-pressure in the reactor.

11. A method as claimed in claim 1, **characterised in that**

- the fibre suspension is taken through two or more precipitation reactors connected in series, in which precipitation reactors the gas spaces may have different compositions, for example in such a manner that
- the gas containing the precipitant in the first precipitation reactor is pure or nearly pure carbon dioxide and in the following precipitation reactor or reactors flue gas or other less carbon dioxide-rich gas or in such a manner that
- the gas containing the precipitant in the first precipitation reactor or reactors is less carbon dioxide-rich gas and in the following precipitation reactor or reactors pure or nearly pure carbon dioxide.

12. A method as claimed in claim 1, **characterised in that**

- the reactive mineral material comprises calcium hydroxide, calcium sulphate, calcium oxide, some other reactive material suitable for the purpose and precipitable with the precipitant and/or a mixture of these, and that
- the reactive mineral material is chosen according to the desired quality of the product, for example, according to the optical properties desired.

13. A method as claimed in claim 1, **characterised in that** the fibre material comprises

  - primary fibre obtained from chemical, mechanical, chemimechanical, thermomechanical, semichemical or other corresponding processes;
  - de-inked or non-de-inked recycled fibre obtained from newsprint, kraft paper, tissue paper, special paper or paperboard, fibre from machine broke or other corresponding fibre,

- bleached or non-bleached fibre, ground or non-ground fibre, dried or non-dried fibre,

or a mixture of these.

14. A method as claimed in claim 1, **characterised in that** the fibre material contains in addition to fine substances, such as fibre-based fines, impurities and/or mineral materials.

15. A method as claimed in claim 1, **characterised in that** the fibre material is fed to the precipitation reactor at a consistency of 0.1–40%, more typically 1–15%, most typically 3–7%.

16. A method for producing paper, in which a filler containing paper pulp is fed at a predetermined consistency to the forming section of the paper machine, water is removed from the paper pulp by allowing the pulp to drain through a permeable forming base, such as a wire, and the paper web thus produced is dried and finished in order to produce a finished paper product, whereby the fibre material used as the raw material for the paper pulp is pretreated in order to activate the fibres and the fibre surfaces, for example in such a manner as to enhance their capacity to bond mechanically or chemically, to enhance their capacity to bind mineral material mechanically or chemically, to form active OH-groups on their surfaces, and/or that their inner part (lumen) opens up allowing, among other things, the mineral material to precipitate also into the fibres, **characterised in that** the method comprises pretreatment of the fibre material in a flow-through mixer operating by the impact mill principle, in which

- there are several, typically 3–8, most typically 4–6, concentric cages provided with blades, of which at least every other cage functions as a rotor, and the cages adjacent to said cages function as stators or rotors, the speed difference of the adjacent cages being 10–500 m/s, preferably 50–200 m/s,
- feeding apparatus for feeding the fibre material mainly into the centre of said cages and

- an open outer cage that allows the fibre suspension to flow radially outwards through the cages to exit the cage in different directions, or an outer cage that is provided with one or more outlets in order to discharge the fibre suspension flowing radially outwards from the cages,

whereafter the mineral material is precipitated onto the surface of the fibres by bringing the fibre suspension into contact with the precipitant precipitating the mineral material, and whereafter the paper pulp containing the fibre suspension is fed to the forming section of the paper machine and paper is formed by allowing the pulp to drain through a water permeable forming base.

17. A method as claimed in claim 16, **characterised in that** the activation is performed while the fibres are swollen due, for example to adding $Ca(OH)_2$.

18. A paper, which is made by using fibres that have been pretreated according to any of the pretreatment methods described in claims 1–17 in the paper pulp, at least partly, whereby the paper pulp comprises at least 20 wt-% of nano-sized filler particles, especially PCC, in relation to the total weight of the pretreated fibre.

19. A paper as claimed in claim 18, **characterised in that** its fibre raw material consists entirely of the above-mentioned pretreated fibres.

20. A paper as claimed in claims 18 or 19, **characterised in that** it is sized with wet end size.

21. A paper as claimed in claims 18, 19 or 20, **characterised in that** it is calendered and/or coated paper.